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International application number: PCT/IL05/000158

International filing date: 09 February 2005 (09.02.2005)

Document type: Certified copy of priority document

Document details: Country/Office: IL

Number: 160308

Filing date: 10 February 2004 (10.02.2004)

Date of receipt at the International Bureau: 15 March 2005 (15.03.2005)

Remark: Priority document submitted or transmitted to the International Bureau in

compliance with Rule 17.1(a) or (b)



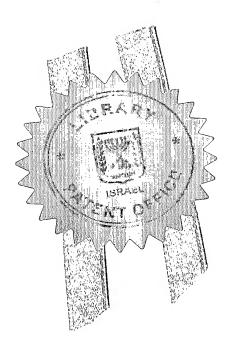


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לשימוש הלשכה חוק הפטנטים, התשכ"ז-1967 For Office Use PATENTS LAW, 1967-5727 מספר: Number 160308 בקשה לפטנט מאריך: PATENT APPLICATION Date 1 0 -02- 2004 אני, (שם המבקש, מענו - ולגבי גוף מאוגד - מקום התאגדותו) I (Name and address of applicant, and, in case of body corporate, place of incorporation) Ante/Post-dated Itshak Y Ben Yesha יצחק בן ישע שילת Shilat ישראל 73188 73188 Israel הממציא: יצחק בן Inventor: Itshak Y Ben Yesha בעל אמצאה מכח\_\_\_היותו הממציא ששמה הוא: of an invention, the Owner, by virtue of being the inventor title of which is: (בעברית) (Hebrew) שיטה למציאת קצב לב Method for determining heart rate (באנגלית) (English) מבקש בזאת כי ינתן לי עליה פטנט. hereby apply for a patent to be granted to me in respect thereof. \*דרישת דין קדימה \*בקשת חלוקה-\*בקשת פטנט מוסף-Application for Division Application for Patent of Addition **Priority Claim** מבקשת פטנט לבקשה/לפטנט מספר/סימן תאריך מדינת האיגור Number/Mark Date from application to Patent/Appl. Convention Country dated dated מיום \*יפוי כח: כללי/מיוחד - רצוף בזה / עוד יוגש P.O.A.: general / specific - attached / to be filed later-Has been filed in case\_ הוגש בעגין המען למסירת הודעות ומסמכים בישראל Address for Service in Israel \_\_\_\_rtshak Ben Yesha יצחק בן ישע\_\_\_\_ \_\_\_\_\_Shilat 73188 שילת היום שנת בחודש חתימת המבקש This of the year February Signature of Applicant 2004 10 פברואר

REFERENCE:

סימוכין:

## **Invention Description for Patent Application**

# Method for determining heart rate

Inventor: Itshak Y. Ben Yesha

#### Method for determining heart rate

Disclosed is a system, apparatus and method for the detection of vital signs, whose novelty is the method for determining heart rate.

Basic to the system of the present invention is an array of at least two pressure-sensitive transducers/gages ("sensors") located under the patient's body, supporting its weight. Summing the signals of all sensors results in a combined signal corresponding to vertical movements of the body, mainly respiratory movements, and to vertical environmental "noise", mainly the product of a vibrating floor. We will call this sum of signals "The Vertical Signal".

**Deducting** of said signals or signal groups from each other results in a combined signal corresponding to horizontal movements of the body's center of gravity, mainly due to blood circulation and movements of body limbs.

We will call this difference of signals "The Horizontal Signal".

In order to determine heart rate, the signals to be <u>deducted</u> from each other are those corresponding to the head side and the foot side of the patient. This is because the blood's center of gravity driven by the heart, moves along the body's axis. The name <u>"Axial"</u> describes the difference between the head side signal and foot side signal, which is the Horizontal Signal when measured along the body axis. The determination of the Axial Signal is a crucial first step for heart rate determination.

When the major position of the patient is stationary (as with adult people in a hospital bed, or a baby in a small crib) the best solution will include two sensors whose connecting line is parallel to the body's axis, or two groups of sensors — a group at the head side, and another at the foot side. The combined signals of the two groups will be deducted from each other to determine the Axial Signal.

When the patient is expected to change the body axis' direction, like a baby in a bed or a pet in a cradle, the best solution will consist an array of at least 3 sensors. Since the body axis is not known, the deduction will be made by mathematically determining the maximum difference of signal within each pair of sensors. This maximal difference is the Axial Signal.

The second step is by using the peeks of the Axial Signal to determine heart rate.

Best solution will be achieved by filtering, normalizing and comparing Vertical and Axial Signals. This will enable an accurate heart rate and respiration rate determination, while rejecting limb movements and mutual artifacts.

Filtering signals in order to determine heart rate should be done using **high-pass filter** whose frequency is <u>at least twice</u> the monitored patient's typical heart frequency. (contrary to the failed efforts known to determine heart rate using high-pass filter whose frequency is lower than the heart rate).

Using low-pass filter whose frequency is at least 6 times the typical heart rate will help to reduce noise.

The best way to build the system is combining the new heart-rate determining technology, with the existing respiratory monitoring technology:

See drawing no 1-

A sensor pad (1) consisting two solid boards, between them an array of 4 pressure sensitive elements (sensors) (3). The pad is located under the mattress of the patient. A cable connects all 4 sensors to the control and processing unit (CPU) (2). The PCU processes all 4 input signals, computing the Axial Signal and the Vertical Signal in accordance with the method described above. Then using filters to isolate heart-beats' and respirations' artifacts from noise and from each other. Both cyclical vital signs are measured and displayed. Another algorithm whose inputs are the heart rate and respiration rate is used to trigger an alarm system, which is an integral part of the CPU.



### Patent

Ben Yesha

# Method for determining heart rate

Drawing No. 1

- (1) Sensor Pad
- (2) CPU
- (3) Pressure Sensitive Elements

